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(72) Inventor WILLIAM ARTHUR GURNEY

1 242 864

(54) ACOUSTICAL ELEMENTS

(71) We, DUNLOP HOLDINGS LIMITED (formerly THE DUNLOP COMPANY LIMITED), a British Company of Dunlop House, Ryder Street, St. James's, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to acoustical elements.

According to the present invention, an acoustical element comprises at least one surface layer including a plurality of apertures and at least one underlying layer comprising a material made substantially of metal which is in the form of a three-dimensional network arranged to define a plurality of cellular spaces which inter-communicate with one another.

The surface layer and the underlying layer may be attached together directly or they may be separated by one or more intermediate layers of a porous material. The layers may be bonded together, for example by means of adhesive or welding or two or more of the layers may be made integral with one another, by coating with metal whilst they are in contact with one another.

The underlying layer is preferably a porous foam made substantially of metal. Where the layer is a porous metal foam it may be produced by spraying, dipping or electrodeposition of the metal on a porous substrate material. The porous substrate material may be in the form of an agglomerate of fibres, such as a felted material, or a sponge-like or foam material, such as natural sponge or a synthetic resinous foam. In general, polyurethane foams are preferred. The porous substrate material may remain in the metal or it may be removed, e.g. by heating to melt or "ash-out" the material.

Where a high degree of porosity is required, the foam may be a reticulated foam, i.e. a foam in which the organic phase is a three-dimensional network with no substantial wall portions defining the cells. Such reticulated foams may be produced by removing the relatively thin cell walls from a foam, e.g. by chemical reagents such as aqueous sodium hydroxide in the case of polyurethane foams.

When the metal is to be electrodeposited it is, of course, necessary either to use a porous material which is electrically conducting or to render the material conducting by means of a conducting surface layer. Non-conductive materials may be made self-conductive by means of an additive such as graphite or a powdered metal. A conducting surface layer may be applied by coating the material with a curable resinous material material incorporating a conductive additive or by chemically depositing a metal thereon, e.g. by the reduction of ammoniacal silver nitrate *in situ*. In general, where chemical deposition is employed the surface should be treated with one or more sensitising agents such as stannous chloride followed by palladium chloride for silver.

Metals which can be electrodeposited include silver, copper, nickel and iron. Alloy foams can be produced in some cases by direct plating and in other cases two or more metals may be deposited successively and the alloy formed by heating the resultant structure. Steel foams can be produced by the incorporation of the required amounts of carbon and/or nitrogen. The carbon may be derived from organic material forming the basic foam or added to an electroplating bath.

The resulting alloy foams can, of course, be heat-treated to give desirable physical properties, such heat-treatments being well known in the art.

The surface layer may be of woven or other mesh-construction having, for example, a mesh size of 10 to 150 meshes per linear inch. The mesh may be, for example, of a plastic material or metal and may have, if desired, a decorative finish.

Alternatively, it may comprise an open-port construction of a material which is the same or different from that of the underlying layer. The porosity of the surface layer should be smaller than that of the underlying layer, for example, suitable porosities for the surface layer are 20 to 100 pores per inch and for the underlying layer 8 to 50 pores per inch.

One particular acoustical element in accordance with the present invention is produced by metallising a plastics foam which comprises at least two layer of different porosity. In this way an integral metal acoustic element can be produced.

If desired, an air gap may be incorporated into the element. The element may be provided with a backing of metal, plastic or other suitable material.

The acoustical elements of the present invention find particular application where it is necessary to have an element which is both fire and heat resistant for example, as duct linings in jet engines, turbines, and air conditioning inlets and outlets. The metal elements are very robust and can be made in a variety of shapes, thereby reducing the necessity for subsequent machining operations.

The invention is hereinafter particularly described with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional drawing of an acoustical element in a silencer.

Figure 2 is a cross-sectional drawing of the rear end of a jet engine provided with an acoustic element.

Figure 3 is a cross-sectional drawing of the rear end of a jet engine provided with an alternative form of acoustical element.

In Figure 1, an acoustical element 10 which is circular in plan is shewn in position in a silencer 11. Thet element consists of a surface layer 12 of a porous foam made substantially of metal and an underlying layer 13 of a porous metal which has a greater porosity than the surface layer 12.

In Figure 2, an acoustical element is shewn in position in the casing 14 of the rear of a jet engine. The element comprises a surface layer 15 of a porous foam made substantially of metal, and an underlying layer 16 of a porous foam made substantially of metal which has a greater porosity than the surface layer 15.

In Figure 3, an acoustical element is shown in position in the casing 17 at the rear of a jet engine. The element comprises two concentric hollow cylinders 23 and 24. The cylinders are attached to each other by means of support members 18. The outer cylinder 24 consists of a surface layer 21 of a porous foam made substantially of metal, and an underlying layer 22 of a porous metal foam which has a greater porosity than that of the surface layer 21. The inner cylinder 23 comprises surface layers 19 of a porous metal foam and an underlying layer 20 of a porous metal foam which has a greater porosity than the surface layers 19.

WHAT WE CLAIM IS:—

1. An acoustical element which comprises at least one surface layer including a plurality of apertures and at least one underlying layer comprising a material made substantially of metal which is in the form of a three-dimensional network arranged to define a plurality of cellular spaces which intercommunicate with one another.

2. An acoustic element according to claim 1 in which the underlying layer has been produced by electrodeposition of a metal on a porous substrate.

3. An acoustical element according to claim 2 in which the porous substrate is a reticulated foam.

4. An acoustical element according to claim 3 in which the reticulated foam is reticulated polyurethane foam.

5. An acoustical element according to any preceding claim in which the surface layer has been produced by electrodeposition of a metal on a porous substrate.

6. An acoustical element according to any preceding claims in which the surface layer has a smaller porosity than the underlying layer.

7. An acoustical element according to claim 6 in which the surface layer has a porosity of from 20 to 100 pores per inch.

8. An acoustical element according to claim 6 or 7 in which the underlying layer has a porosity of from 8 to 50 pores per inch.

9. An acoustical element according to any preceding claim in which one or more intermediate layers of a porous material are positioned between the surface and underlying layers.

10. An acoustical element according to any preceding claims in which the layers have been bonded together by welding.

11. An acoustical element according to any of claims 1 to 9 in which the layers have been bonded together by adhesive means.

12. An acoustical element according to any of claims 1 to 9 in which two or more layers are made integral with one another, by metallising the layers whilst they are in contact with one another.

13. An acoustical element according to any preceding claims in which one or more of the layers have been heat treated.

14. An acoustical element substantially as described herein and shown in the accompanying drawings.

R. I. G. McKAY,
Agent for the Applicants.

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COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

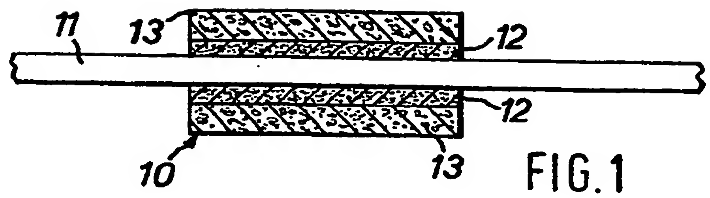

FIG.1

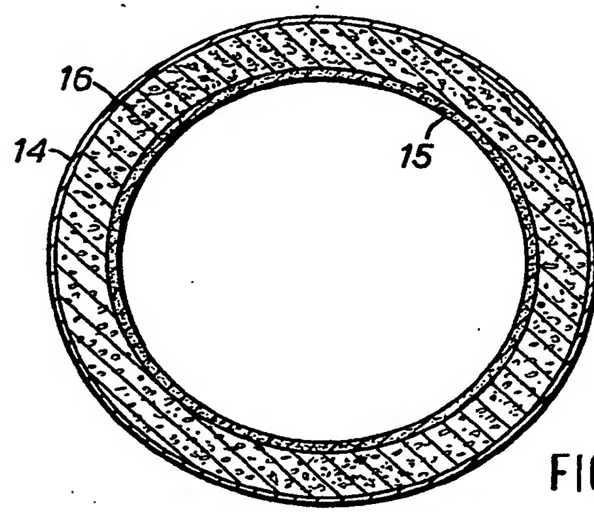

FIG.2

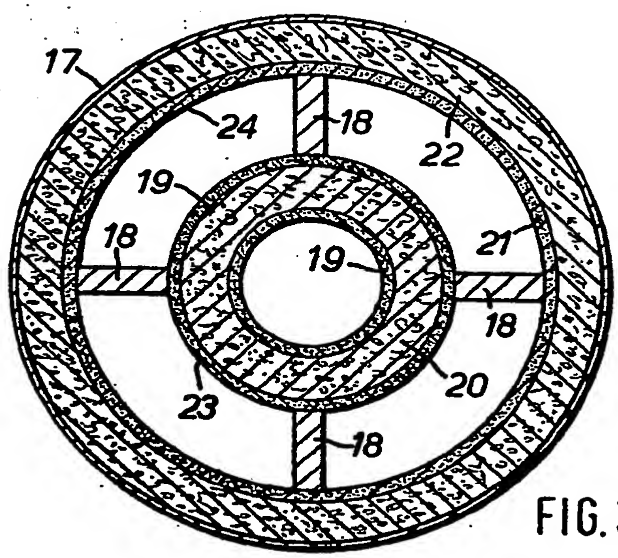

FIG.3